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Description

Method for Safely Coupling an External Voltage Network to an Operating Voltage Network and Circuit Arrangement for Carrying out Said Method

The invention relates to a method for safely coupling an external voltage network to an operating voltage network, in particular of a motor vehicle, and to a circuit arrangement for carrying out said method.

In coupling two voltage networks with each other, care is to be taken that the two voltages are compatible. The parameters of the voltages are their value, their polarity in case of dc voltage and the frequency as well as the phase in case of ac voltage. If there are two voltage networks coupled with each other in which these characteristics are not in conformity, damage in the voltage networks or failure in operation may result.

To avoid damage, it is known to connect fuses in the current path which separate the connection between the voltage networks in case of inadmissibly high current. However, such fuses do not provide protection against too high voltages.

In case of motor vehicles, there is the additional difficulty that different voltage levels will be utilized in the future in the on-board networks of motor vehicles. This constitutes a problem in particular if, in case of failure of the battery of a motor vehicle, a jumper operation is carried out by connecting the on-board network to the on-board network of another vehicle, since there is the risk in that event that different on-board networks are interconnected.

It is an object of the invention to indicate a method that ensures safe coupling of an external voltage network to an operating voltage network, in par-

ticular of a motor vehicle, such that damage to the voltage networks is prevented. According to the invention, this object is met by a method for safely coupling an external voltage network to an operating voltage network, in particular of a motor vehicle, in which at least one controllable switch is arranged between the operating voltage network and a connecting terminal, the at least one controllable switch is connected to a control unit, the connecting terminal is designed for connection of the external voltage network and the method comprises the following steps:

- measuring the voltage at the connecting terminal,
- examining whether the measurement voltage is not below a lower threshold value and not in excess of an upper threshold value,
- closing the controllable switch if the measurement voltage is within the permissible range,
- measuring the current flowing between the connecting terminal and the operating voltage network,
- examining whether the current is not below a lower threshold value,
- opening the at least one controllable switch if the current is outside the permissible range.

The method is advantageous since damage to one of the voltage networks by excess current or overvoltage is prevented on the one hand, while the end of a balancing operation between the networks is recognized as well on the other hand, namely when the current drops below a preset threshold value.

Furthermore, it is advantageous that a permissible voltage range may be preset within which the voltage of the external voltage network may reside.

It is particularly advantageous that no parts, such as e.g. fuses, have to be replaced upon occurrence of an error. Locking after opening of the switch is advantageous since uncontrolled re-activation of the controllable switch is thus prevented.

An expedient circuit arrangement for carrying out the method is designed such that the controllable switch is a relay.

According to a further development of the invention, the connecting terminal is covered by a cap, and the latter is coupled to a switch or a sensor so that the beginning of the coupling operation is recognizable by removal of the cap.

Further details and developments of the invention are indicated in the dependent claims.

The invention will be explained in more detail hereinafter by way of an embodiment shown in the drawings in which

Fig. 1 shows a block diagram of a circuit arrangement for implementing the method according to the invention in a vehicle environment, and

Fig. 2 shows a representation of the method according to the invention in the form of a block diagram.

Fig. 1 shows a switching unit SG for implementing the method according to the invention in a vehicle environment. This figure thus shows at the same time a circuit arrangement according to the invention.

The arrangement of Fig. 1 consists in essence of three blocks, namely an operating voltage network BN coupled to an external voltage network FN via a switch Q_2 of a switching unit SG and via a connecting terminal VK having a jumper cable SK connected thereto. In addition to an on-board network BN1, the operating voltage network BN of a first vehicle A comprises a starter motor S1, a battery with a voltage U_{A1}, a voltage transformer W as well as a second battery with a voltage U_{A2}. The external voltage network FN in the present embodiment is illustrated as network of a second vehicle

B. The latter has an on–board network BN2, a starter motor S2 as well as a battery with a voltage U_B.

The voltage supply concept making use of two batteries with different voltages copes with future vehicle generations in which the starter circuit is operated with 36 V, for example, whereas the on–board network is operated with conventional apparatus and instruments using 12 V.

The switching unit SG is allocated to the first vehicle A. It is arranged between connecting terminal VK and operating voltage network BN. Switching unit SG comprises a control unit SE, the controllable switch Q_2, a measurement resistor R_m, an additional switch Q_1 as well as a third switch Q3. Switch Q_1 interrupts the voltage supply of control unit SE. Controllable switch Q_2 is controlled by control unit SE. In addition thereto, control unit SE is connected to connecting terminal VK, so that the voltage U_{VK} at the connecting terminal VK can be determined via this line. In addition thereto, a current measuring means ME_I is connected in the current path between connecting terminal VK and operating voltage network BN, with a connecting being also provided between current measuring means ME_I and control unit SE. A display unit AE is connected to control unit SE.

Switch Q_1 may be connected to the ignition lock of vehicle A or to another control unit. An additional switch Q_3 may be connected thereto in addition, said switch Q_3 being arranged in series or in parallel to switch Q_1. In an expedient embodiment, said switch Q_3 is coupled to a cap AK that hides connecting terminal VK and has to be folded away for connection of a jumper cable SK. Anyway, the switch Q_1, or the combination of switches Q_1 and Q_3, has the effect that the switching unit SG measures current and voltage only when the vehicle is operative or when an external starting operation or jumper operation is being carried out.

The mode of operation and the cooperation of the individual components takes place in accordance with the flow diagram according to Fig. 2. The sequence relates to an embodiment according to Fig. 1, with switch Q_1 be–

ing controlled by the ignition lock. After the ignition lock Q_1 has released the voltage supply of control unit SE, the terminal voltage U_{VK} at the connecting terminal VK is measured. If the voltage is within a specific range that is limited by threshold voltages U_{min} and U_{max}, switch Q_2 is closed. If the voltage is not within this range, the measurement of the terminal voltage U_{VK} is continued and switch Q_2 remains open. If there is no external voltage network FN connected, there is no voltage applied to connecting terminal VK, either, and switch Q_2 is not closed. Upon closing of switch Q_2, there is a current I flowing over the current path from connecting terminal VK to the battery with the voltage U_{A2} and the voltage transformer W, respectively. It is possible to determine from this current I whether there is an error present in the charging circuit, namely when the current is higher than a maximum value I_{max}, or whether the battery is charged sufficiently, namely when the current drops below the threshold I_{min}. If the current measured is between I_{min} and I_{max}, switch Q_2 remains closed, and if the current is outside of this range, switch Q_2 is opened. If the current drops below the minimum value I_{min} upon sufficient charging of the battery, a starting operation can be carried out via the ignition lock. In a preferred embodiment, switch Q_2 is in the form of a relay. Another possibility would be to realize the switch Q_2 as load disconnecting switch which may be electrically switched on again. The current I between connecting terminal VK and operating voltage network BN, of course, may flow also in the opposite direction if vehicle A performs a jumper operation. The vehicle is protected in that event as well.

Upon opening of Q_2, the measurement of the terminal voltage U_{VK} is continued, but a locking feature prevents the switch Q_2 from closing again. The locking is released only when the voltage U_{VK} at connecting terminal VK drops to zero or below the lower threshold value U_{min}, i.e. when the jumper cable SK is disconnected from connecting terminal VK. Upon release of the jumper cable SK, the switching unit SG returns to the normal state, so that the operation starts anew. If switch Q_3 is coupled to a covering cap AK, the locking feature may also be effected depending on this cap. Preferably, locking is controlled by control unit SE, for example by corresponding connection or programming of the control logic. If a load disconnecting switch is

employed, reactivation can be delayed until the terminal voltage U_{VK} has dropped to zero.

In accordance with a further development of the invention, switch Q_2 is closed at regular intervals and a measurement is carried out so as to thus check automatically whether a new starting or charging operation is to be started or whether a previous error is still present. Sampling of switch Q_1 and possibly switch Q_3 may also be part of this checking operation. This is realized in the drawing figure by a timer that releases the locking state at regular intervals by a corresponding control signal.

Switching unit SG may comprise several controllable switches. The number of switches is dependent on whether the connection is to remain separated in case of incompatibility of the voltage networks only, for example, as described so far, or whether the external voltage network FN is to be coupled to one of several partial systems of the operating voltage network BN, depending on the particular voltage of the external voltage network FN. Additional switches or additional contacts in the switches provided, so that change-over switches are formed, are required if, in case of different polarities of the external voltage network FN and the operating voltage network BN, this is to be corrected automatically.

When dc voltage networks are coupled, for which the method according to the invention and the circuit arrangement according to the invention, respectively, are suitable just as well, the circuit arrangement becomes more complex. In addition to the voltage value or voltage amplitude, the frequency and the phase position have to be taken into consideration. Instead of a dc to dc converter, transformers may be used here. It is also conceivable that DC/AC converters or AC/DC converters may be utilized. In coupling three-phase current networks, the phase sequence of the three conductors is to be considered in addition. The coupling method according to the invention, however, remains the same in all cases and only the circuit arrangement needs to be supplemented by corresponding components.